IV. Remarks

Originally filed claims 1-32 stand rejected. Reconsideration of all other rejections in light of the Amendment set forth above and the following arguments are respectfully requested.

A. Objection to the Disclosure

The Official Action sets forth five objections to the disclosure for which appropriate correction is required. It is respectfully submitted that the amendments to the specification set forth above address and overcome each one of those objections.

B. Claims Objections

The Official Action objected to claim 32 because claim 32 is a method claim that depends from claim 16 which is an apparatus claim.

Appropriate correction of which is required. As indicated above, claim 32 has been amended to depend from independent claim 34 which is a process claim thereby overcoming the objection set forth in the Official Action.

C. Claim Rejections Under 35 U.S.C. § 112

The Official Action rejected claims 1-32 under 35 U.S.C. §112, second paragraph, stating that claim 1 recites a process for the operation of a laser device but fails to recite any structural devices slant elements for carrying out the process outline. In addition, claim 16 recites a "compensating mechanism" and a "dispersion setting device" without providing sufficient structure to properly conform these elements. As stated above, claims 1 and 16 have been cancelled. Claim 1 has been rewritten as independent claim 33 which incorporates the features of previous claims 1 and 4 and which overcome the Examiner's rejection of claim 1 under 35 U.S.C. § 112. In addition, claim 16 has been cancelled and rewritten as independent claim 35 which incorporates the features of originally filed claims 16 and 19 and which overcomes the rejection of originally filed claim 16 under U.S.C.§ 112.

D. Claim Rejections Under 35 U.S.C. § 102(b)

The Examiner rejected claims 1-32 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5, 212, 698 (Kafka at al.), U.S. Patent No. 6,038,055 (Hansch et al.), and U.S. Patent No. 5,054,027 (Goodberlet et al.).

It is respectfully submitted that the claims to the present application, as amended, are patentable over Kafka et al. for the following reasons.

Kafka et al. do not disclose the introduction of a predetermined linear dispersion into the light path of the resonator arrangement for setting a predetermined frequency of at least one frequency mode a predetermined mode separation between the frequency modes.

The difference between the group velocity dispersion and the linear dispersion mentioned in e.g. claim 1 is essential for understanding the novelty of the claimed invention. Therefore, this difference is illustrated in the following.

The group velocity dispersion (or: dispersion of second order) is a general property of all materials, in particular of the media in the laser resonator passed by the light pulses. The various partial frequency modes (with different optical frequencies) have different velocities in dispersive materials. As a result, the light pulses show an inherent broadening. For fulfilling and maintaining the resonance condition in the resonator, a correction or compensation of the group velocity dispersion is obtained by introducing optical components with a negative group velocity dispersion (see textbook entitled "Femtosecond Laser Pulses Principles and Experiments", chapter 2.2.4.2, pages 36, 38, a copy of which pages are attached hereto). In the present case (Fig. 1) this compensation is obtained by the pair of prisms 41, 42.

In contrast, the linear dispersion (or: dispersion of first order) is a material property resulting in a time delay of the dispersion, the velocity of the pulses decreases without changing the pulse shape.

In conventional laser devices, the linear dispersion does not play any role for the pulse properties. Therefore, the linear dispersion has not been considered before the invention, in particular in the description of the physical properties of laser resonators or e.g. in the Kafka patent.

The Kafka patent discloses the conventional generation of ultra-short light pulses in a resonator arrangement with a titan-sapphire-laser. Any spectrally specific change of the frequency of single modes or of the mode separation is not disclosed in the Kafka patent. With this regard, particular reference is made to Figs. 3a-3c of the Kafka patent. Each of the resonators shown in these figures has a device for compensating the group velocity dispersion

(prism pairs 50, 52). At the end of the resonator, a plane mirror 54, a mirror-slit-combination 54, 56 or a tiltable, curved mirror 60a is provided.

Not any of these components 54, 56 or 60 is capable to introduce a predetermined linear dispersion, i.e., to set the linear dispersion on certain values spectrally influencing single modes a presently claimed.

The single mirror 54 represents a simple reflector only (resonator end mirror). The mirror-slit-combination 54, 56 allows a shifting of the envelope yielding masking of underlying modes (i.e., frequency components) from the light pulses without influencing the modes themselves. The spectral composition of the light pulses is modified like with a so-called Lyot filter. It is not possible to adjust single modes to certain frequency values by this technique. Finally, the curved mirror is arranged for a spectral shift of the envelope of the light pulse spectrum. An adjustment of frequencies is impossible.

Due to the following feature, the curved mirror 60 has a masking function like the mirror-slit-combination. Near the optical axis, the mirror surface corresponds to a plane perpendicular to the optical axis. Outside the central portion, the mirror surface deviates from the plane. Due to this deviation, the modes outside the optical axis are deflected from the resonator (masking). By a tilting of the curved mirror, the spectrum of the light pulses can be shifted as such. Please find attached illustrating Figs. A and B, which show the difference between the spectral shift obtained with Figs. 3b or 3c of the Kafka patent and the technique claimed in the present patent application. By adjusting the slit according to Fig. 3b or by titling the curved mirror according to the Fig. 3c, the envelope of the frequency comb is shifted in the THz range. The frequencies of the individual modes (e.g., f_1) are not influenced. However, after the adjustment certain (masked) modes like e.g. f_1 do not longer contribute to the laser process.

In contrast to Fig. !, the present invention teaches an adjustment of the frequencies as illustrated in Fig. B. The modes are shifted in the MHz-range without an essential modification of the envelope. This mode adjustment is explained in the present description (page 14, ph. 2, to page 16, ph. 3).

With regard to the novelty of the claimed invention it is important to emphasize that the introduction of linear dispersion influencing single modes of a light pulse is impossible with the

Kafka technique. As an example, the function of the mirror 34 shown in Fig. 1 of the present patent application cannot be fulfilled by any optical component described by Kafka. The present tiltable mirror 34 is a plane mirror onto which the modes hit with a certain inclination. The resonator length is changed for each mode in a different manner as the spectral components of the pulses are separated from each to her at the mirror 34. Therefore, the resonator length is subjected to a spectrally specific variation different for each mode. Accordingly, the frequency position of the modes can be set to a certain value. This influence is not obtainable with e.g. the curved mirror 60 of the Kafka patent as this curved mirror does not allow a spectrally specific variation of the resonator length.

With regard to the inventive step, the following arguments are emphasized. Firstly, the Kafka patent does not give any indication with regard to the introduction of a predetermined linear dispersion for a spectrally specific frequency change of the modes of circulating light pulses. Secondly, the claimed generation of ultra-short light pulses provides a generally new operation principal for laser devices. For the first time, the possibilities of pulse shaping and setting pulse parameters are completely used. This allows a plurality of new and improved applications of ultra-short light pulses as described in the application.

The above arguments supporting the patentability over the Kafka patent are true with regard to both the process and device claims.

Due to the following reasons, the remaining citations, in particular the Hansch patent and the Goodberlet patent represent technological background in the field of laser resonators only. The Hansch patent represents technological background with regard to the superposition of circulating light pulses in resonator devices. The light pulses (21, see Fig. 1) are coupled into a resonator 1. The resonator 1 is a passive resonator, which cannot be used as an active laser device. As soon as the circulating light pulses have reached a predetermined minimum energy, output light pulses are coupled out (reference No. 31).

Hansch et al. do not disclose any introduction of a certain linear dispersion into the resonator for influencing the frequency of at least one mode separation between the modes forming the light pulses. Therefore, the claimed invention is new over the Hansch patent.

Furthermore, Hansch et al. do not give any indication to amend e.g. the Kafka technique according to the invention.

The Goodberlet patent represents technological background with regard to the light pulse formation by so-called mode locking. According to Goodberlet et al., a laser resonator is combined with an additional intensity dependent non-linear cavity allowing to shorten emitted light pulses. Goodberlet et al. are completely silent with regard to the claimed introduction of a linear dispersion.

In view of the above, it is respectfully submitted that the claims of the present application, as amended, are allowable. Accordingly, reconsideration of the present application and an early Notice of Allowance is earnestly solicited.

Date: October 10, 2003

Respectfully submitted,
Ronald Holzwarth
By: Joseph A. Powers

Joseph A. Powers, Reg. 47,006
Attorney For Applicant

DUANE MORRIS LLP
One Liberty Place
Philadelphia, Pennsylvania 19103-7396
(215) 979-1264 (Telephone)
(215) 979-1020 (Fax)